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Half Diallel Analysis in Maize (*Zea mays* L.)

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Half diallel crosses in the genetic analysis of maize (*Zea mays* L.), focusing on combining ability, genetic variability, and the implications for maize breeding. Half diallel designs are pivotal for evaluating the genetic potential of inbred lines, allowing breeders to identify superior combinations that enhance yield and adaptability. In order to estimate general and specific combining ability effects and identify superior genotypes resistant to Sesamia cretica, a half diallel cross between nine yellow inbred lines of maize (*Zea mays* L.) was evaluated under two environments, namely borer artificial infestation conditions and normal conditions in RCBD with three replications in 2024. For every attribute under investigation, highly significant cross mean squares were found, demonstrating the great diversity of the parental materials used in this investigation. The results indicate that both additive and non-additive gene effects were involved in determining the performance of the single cross progeny. Specifically, general and specific combining ability (GCA and SCA) were significant for all the examined variables, with the exception of SCA for number of rows/ear under normal condition. The inbred parental line P6, P8, and P9can be considered as good combiners for grain yield and some of its component traits under infestation andnon-infestation conditions as well as the combined over them.

Key words: inbred , GCA ,SCA, half diallel

Introduction

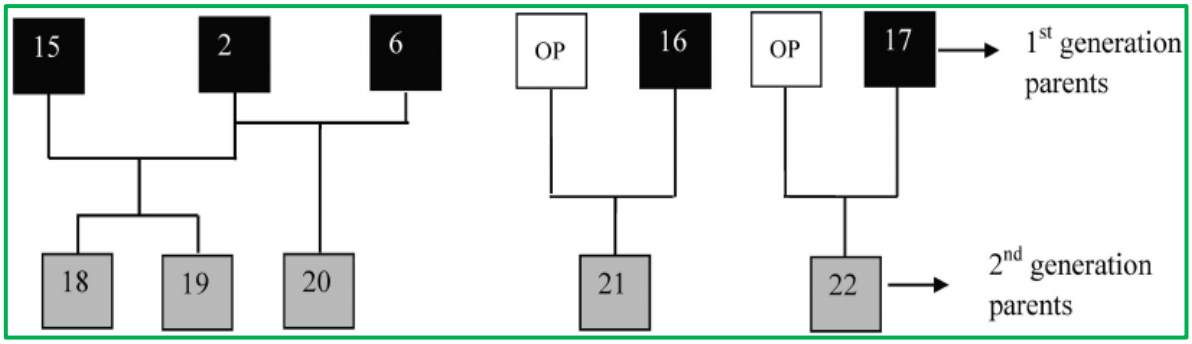
Maize is a crucial staple crop globally, providing food and economic stability. Genetic diversity plays a vital role in breeding programs aimed at improving yield and resilience against biotic and abiotic stresses. Diallel crossing systems, particularly half diallel crosses, are widely employed to assess the combining ability of parental lines and to analyze genetic variation. Zea mays L., or maize, is one of the most important grains in Egypt and the world because of its large growing area, high overall production, and high financial value. For livestock and human consumption, it is necessary. Furthermore, industrial uses for it include the production of cooking oils and flour. Numerous research projects aim to boost its output via genetic enhancement. Different types of Lepidoptera pests, commonly known as corn borers, severely harm maize plants in Egypt. Three types of corn borers are attacking maize in Egypt: the purple-lined corn borer Chilo Agamemnon Bles. (Crambidae), the European corn borer (ECB) Ostrinia nubilalis Hubn (pyroustidae), and the pink stem borer Sesamia cretica Led. (Noctuidae). In Egypt, Sesamia cretica is the most common corn borer that preys on young maize.

Cultivating insect-resistant cultivars is one of the most crucial strategies for managing insect pests in the framework of integrated pest management (Pathak 1991). Finding sources of resistance and figuring out how plant behavior under insect attack is passed from the original parents to the improved cultivars is the first stage in creating an effective breeding

program for resistance to a particular insect (Pathak and Othieno 1992). A lot of work has gone into finding and creating maize germplasm that is resistant to Sesamia cretica, the pink stem borer, (Al-Naggar et al. 2000, Saafan 2003, Soliman 2003). The inheritance of resistance to Ostrinia nubilalis and Sesamia nonagrioides has been reported to be caused by both additive and non-additive gene activity (Velasco et al. 2002).

Methodology

1.Half Diallel Design: In a half diallel cross, a selected group of inbred lines is crossed to form hybrids, but each line is crossed only once with every other line, avoiding reciprocal crosses. This design allows the evaluation of both general combining ability (GCA) and specific combining ability (SCA), providing insights into the additive and non-additive genetic variance.



The picture of half diallel (source fikre ishki)

Differences: Different half diallel designs exist, such as ones that lack reciprocal crossings and those that have parents.

contrasting with a complete diallel: Although full diallel designs enable testing for both maternal and paternal effects, they require twice as many crossings and entries than half diallel designs.

Evaluation: Combining ability over environments in diallel designs can be analyzed using the DIAL-SAS computer tool.

2.Parental Selection: Selection is based on traits of interest, including yield, resistance to diseases, and stress tolerance. Careful selection ensures that the resultant hybrids exhibit desirable traits.

For example

12 × PFSR 15016-1 GYL: Because it showed a significant and desired sca effect for features including ear length, ear girth, number of grains per row, weight of 100 kernels, and seed starch content, this cross was deemed to be the best.

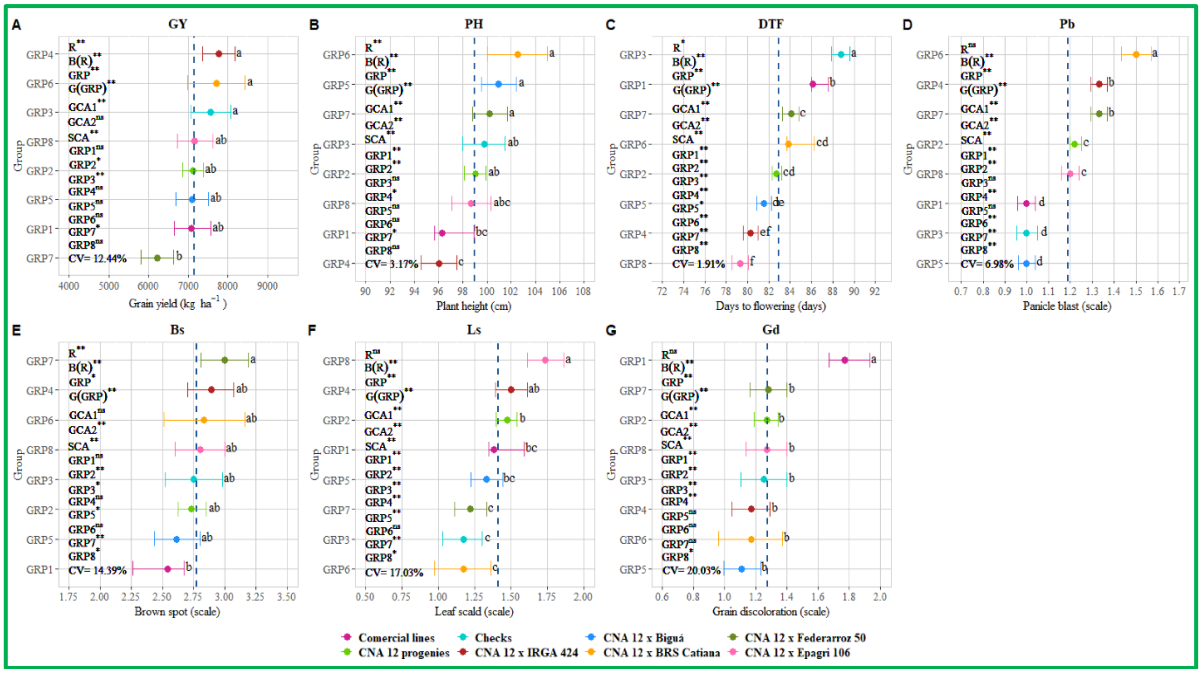
15016-1 x GYL 7 PFSR: When it came to protein composition, this cross exerted the greatest significant sca in the desired direction. .

P1×P6, P1×P7, P2×P4, P3×P5, P5×P7, and P8×P9 These crosses showed substantial SCA impacts for grain yield and the highest mean values in the combined analysis.

Statistical Analysis: Various models, such as the Griffing method, are utilized to analyze the data. The estimation of GCA and SCA is crucial for understanding the genetic contributions of the parents.To ascertain the significance of variation between genotypes and blocks, analysis of variance (ANOVA) is employed.

The method of least significant difference (LSD): used to assess how well hybrids and paternal inbred lines perform on average.

Variance in general combining ability (GCA): In order to ascertain the predominance of additive and additive by additive gene effects, SCA variance is contrasted with this.



Selectin of parents source (Guimarães *et al*)

Results

Combining Ability: Studies have shown significant differences in GCA and SCA among maize inbred lines. High GCA indicates that a line consistently transmits desirable traits to its offspring, while SCA identifies specific hybrid combinations that perform exceptionally well. According to a study, the main factor influencing the inheritance of all traits—aside from grain production and 100 kernel weight—is non-additive genetic variance. Finding reliable general combiners. Parents PFSR R2-4, GYL 12, GYL 7, and LM 6 were determined to be good general combiners for grain yield in the study. Recognizing exceptional crosses GYL 12 x PFSR 15016-1, GYL 12 x PFSR S3-4, and PFSR S3-5 x GYL 7 were shown to have exceptional grain yields. Identifying a cross with favorable SCA consequences According to a study, the cross P5 × P8 had the greatest mean value for grain yield and favorable SCA effects for numerous characteristics.

Yield and Agronomic Traits: Half diallel crosses have been instrumental in identifying hybrids with superior yield potential and improved agronomic traits. Research has demonstrated that specific crosses can enhance drought tolerance and resistance to pests and diseases. The qualities of crops that affect their quality, productivity, and resilience to stress are known as agronomic attributes. Among the agronomic features are the following:

1.Height of plant

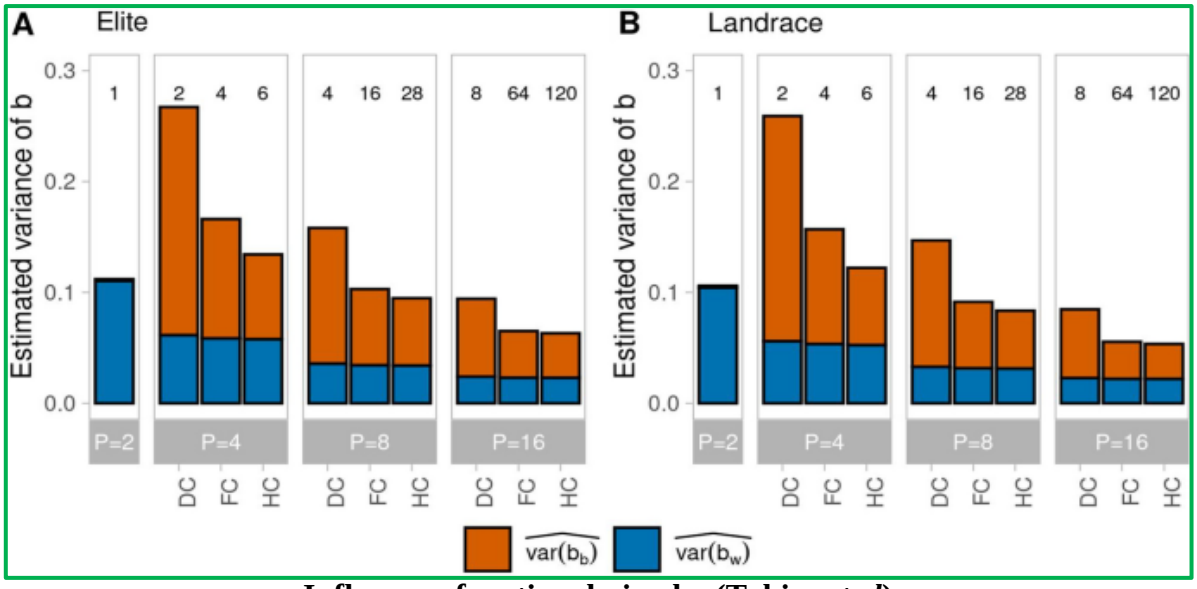
2.Tillering capacity Root mass and length

3.Grain weight and size

4.Resistance to illnesses, pests, and environmental factors

Genetic Variability: The analysis of half diallel crosses often reveals substantial genetic variability among the hybrids. This variability is essential for selection and can facilitate the development of new cultivars with enhanced performance.

Gene effects: additive and non-additive: In maize, both additive and non-additive gene effects play a significant role in phenotypic inheritance. For several features, for instance, the GCA/SCA ratio was more than unity, demonstrating the significance of additive gene action.



Influence of mating design by (Tobias *et al*)

Effects of general combining ability (GCA): For particular qualities, some parents made good general combiners. For grain production, for instance, parents PFSR R2-4, GYL 12, GYL 7, and LM 6 were effective general combiners. Crosses The grain output of several crosses was exceptional. For instance, it was thought that the cross GYL 12 x PFSR 15016-1 produced the highest grain yield.

Genotypes through interaction with the environment: With the exception of plant height, genotypes by environment interaction (G × E) were significant for every trait examined.

Discussion

The use of half diallel crosses in maize breeding provides valuable insights into genetic interactions and the inheritance of traits. GCA is particularly important for traits with a strong additive genetic component, while SCA is crucial for traits influenced by non-additive effects. However, limitations such as environmental interactions and the need for extensive testing remain challenges in this approach. Future research could benefit from integrating molecular techniques, such as genomic selection and marker-assisted breeding, to enhance the efficiency and accuracy of breeding programs. These approaches can complement traditional methods and facilitate the rapid development of improved maize hybrids.

Conclusion

Half diallel crosses are a powerful tool in maize genetic analysis, providing insights into combining ability and genetic diversity. The findings from such studies are vital for developing high-yielding and resilient maize cultivars, ultimately contributing to food security and agricultural sustainability.

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